Chapter 1
Introduction

1-1. Purpose

This manual provides technical specifications and procedural guidance for control, geodetic and precise structural deformation surveying. It is intended for use by engineering, topographic, and construction surveyors performing control or deformation surveys for civil works, military construction, and environmental restoration projects. Procedural and quality control standards are defined to establish uniformity in control survey performance and contract administration.

1-2. Applicability

This manual applies to HQUSACE elements, major subordinate commands (MSC), districts, laboratories, and field operating activities (FOA) having responsibility for the planning, engineering and design, operations, maintenance, construction, and related real estate and regulatory functions of civil works, military construction, and environmental restoration projects. It applies to control surveys performed by both hired-labor forces and contracted survey forces. It is also applicable to surveys performed or procured by local interest groups under various cooperative or cost-sharing agreements.

1-3. References

Required and related publications are listed in Appendix A.

1-4. Explanation of Abbreviations and Terms

Control surveying terms and abbreviations used in this manual are explained in the Glossary (Appendix B).

1-5. Background

a. A control survey consists of establishing the horizontal and vertical positions of points for the control of a project site, map, or study area. A geodetic control survey takes into consideration the size and shape of the earth; it implies a reference ellipsoid which represents the geoid and the vertical control datums. A structural deformation survey involves the accurate measurement of short-term and long-term structural deflections or deformations. Geodetic survey techniques are used in performing deformation measurements.

b. Conventional survey techniques are those which use traditional ground survey instruments. They do not include Global Positioning System (GPS) control survey techniques. Typically, conventional survey techniques include traverse, triangulation, trilateration, and differential leveling.

c. Control survey techniques can be used to formulate accurate, three-dimensional point positions. Positions obtained through control surveying may be used to provide the primary reference control monument locations for engineering and construction projects, from which detailed site plan topographic mapping, boundary demarcation, and construction alignment work can be performed. Positions obtained through control surveying have application in the continuous positioning of marine construction vessels, such as dredges and survey boats. Also, various control survey techniques can be used to effectively and efficiently monitor and evaluate large structures, such as locks and dams.

1-6. Scope of Manual

This manual covers the use of control survey techniques (horizontal and vertical) for establishing and/or extending project construction or boundary control. Azimuth determination procedures, data reduction and adjustment methods, and control surveying techniques are outlined. A primary emphasis of this manual centers on the technical procedures for performing precise surveys in support of structural deformation monitoring.

a. The manual is intended to be a reference guide for control and deformation surveying, whether performed by in-house hired-labor forces, contracted forces, or combinations thereof. General planning criteria, field and office execution procedures, and required accuracy specifications for performing control surveys are provided. Accuracy specifications, procedural criteria, and quality control requirements contained in this manual should be directly referenced in the scopes of work for Architect-Engineer (A-E) survey services or other third-party survey services. This ensures that standardized procedures are followed by both hired-labor and contract service sources.

b. The specific project control survey procedures and standards are designed to achieve adequate and economical results to support USACE engineering and construction activities. Thus, the primary emphasis of the manual centers on performing Second- and Third-Order accuracy surveys. This accuracy level will provide adequate reference control from which supplemental real estate,

engineering, construction layout surveying, and site plan topographic mapping work may be performed. Therefore, the survey criteria, given in this manual, are not intended to meet the Federal Geodetic Control Committee (FGCC) (now the Federal Geodetic Control Subcommittee (FGCS)) standards and specifications required for densifying the National Geodetic Reference System (NGRS). However, following the methods and procedures given in this manual will yield results equal to or exceeding FGCS Second-Order relative accuracy criteria. Second-Order accuracy is sufficient for USACE engineering and construction work.

c. When a project requires NGRS densification, or such densification is a desirable by-product and is economically justified, USACE Commands should conform to the more rigorous FGCS "Standards and Specifications for Geodetic Control Networks." This includes related automated data recording, submittal, and project review requirements mandated by FGCS and the National Geodetic Survey (NGS). Details outlining the proposed use of control surveying techniques, including specific requirements for connections to the NGRS, shall be included in the descriptions of surveying and mapping activities contained in project authorization documents.

d. This manual does not cover the theory and physical concepts of GPS survey techniques. For further specific guidance on all aspects of GPS surveying, the user should consult EM 1110-1-1003.

1-7. Life Cycle Project Management Applicability

Project control may be used through the entire life cycle of a project, spanning decades in many cases. During initial reconnaissance surveys of a project, control should be permanently monumented and situated in areas that are conducive to the performance or densification of subsequent surveys for contract plans and specifications, construction, and maintenance. During the early planning phases of a project, a comprehensive survey control plan should be developed which considers survey requirements over a project's life cycle, with a goal of eliminating duplicate or redundant surveys to the maximum extent possible.

1-8. Metrics

Both non-SI and metric units are used in this manual. Metric units are commonly used in control surveying applications, including the control survey work covered in this manual. Control surveyed geographical or metric Cartesian coordinates are generally transformed to non-SI units of measurements for use in local project reference and design systems, such as State Plane Coordinate System (SPCS) grids. In all cases, the use of either metric or non-SI units shall follow local engineering and construction practices. Non-SI/metric equivalences are noted where applicable, including the critical--and often statutory--distinction between the U.S. Survey Foot (1,200/3,937 meters (m) exactly) and International Foot (30.48/100 m exactly) conversions.

1-9. Trade Name Exclusions

The citation or illustration in this manual of trade names of commercially available survey products, including other auxiliary surveying equipment, instrumentation, and adjustment software, does not constitute official endorsement or approval of the use of such products.

1-10. Accompanying Guide Specifications

Appendix C provides guide specifications which can be used to support A-E service contracts for control surveying.

1-11. CORPSCON

A conversion program, CORPSCON, that performs datum conversions for the continental U.S. has been developed by the U.S. Army Topographic Engineering Center (TEC). Technical documentation and operating instructions are given in Appendix D.